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Indian Standard

SPECIFICATION FOR
B-CHAIN ELECTRO-ACOUSTIC RESPONSE
OF MOTION-PICTURE SOUND
REPRODUCTION SYSTEM

(First Revision)

UDC 778.554.4 : 534.86

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

Indian Standard

SPECIFICATION FOR B-CHAIN ELECTRO-ACOUSTIC RESPONSE OF MOTION-PICTURE SOUND REPRODUCTION SYSTEM

(*First Revision*)

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Indian Standard

SPECIFICATION FOR B-CHAIN ELECTRO-ACOUSTIC RESPONSE OF MOTION-PICTURE SOUND REPRODUCTION SYSTEM

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 28 October 1986, after the draft finalized by the Cinematographic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard was first published in 1974 and is revised to modify requirements and method of measurement to take into account the room size and reverberation time.

0.3 This standard refers to the B-chain (final chain), which embraces the reproduction equipment as shown in Fig. 1 and the listening area or auditorium.

It is emphasized that, in practice, the satisfactory reproduction of sound in a listening room or auditorium is also dependent upon the alignment and performance of the A-chain (*see* Fig. 1) of the installation. It is, therefore, essential that the A-chain be correctly aligned with the tolerances of appropriate standard by the use of the appropriate photographic or magnetic test film and, where applicable, the appropriate de-emphasis applied. When magnetic masters are being mixed for release as pre-emphasized sound tracks, it is necessary to add the relevant A-chain characteristic to the B-chain monitor characteristic.

0.4 A separate standard has been prepared on A-chain frequency response for reproduction of 35 mm and 70 mm magnetic striped prints (IS : 12018-1986*).

*A-chain reproduction characteristics of magnetic sound records on 35-mm and 70-mm striped prints.

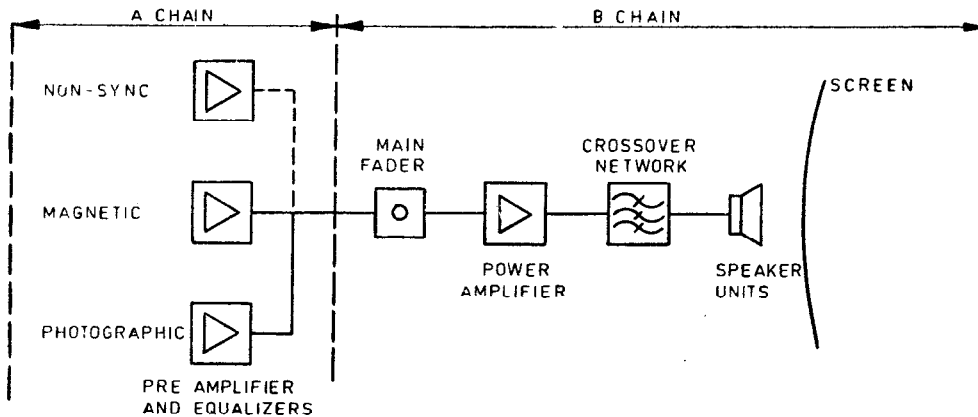


FIG. 1 COMPLETE THEATRICAL SOUND REPRODUCING SYSTEM

0.5 It is recommended that preliminary checks are made for gross acoustic errors prior to measuring the electro-acoustic response as described in this standard. Typical checks include verification that the loudspeaker being measured is close enough to the screen to avoid any behind screen echos, that there is no interference from masking or curtains, and a quick verification that the loudspeaker distribution is sufficiently smooth throughout the listening room or auditorium. This latter test can easily be performed by ear if wide-band pink noise is available as a test signal.

0.6 In the preparation of this standard assistance was derived from ISO/DIS 2969. Cinematography—B-Chain Electro-Acoustic Response of Motion Picture Control Rooms and Indoor Theaters—Specifications and Measurements, issued by International Organization of Standardization (ISO).

1. SCOPE

1.1 This standard gives the characteristics and methods of measurement of the B-chain response of motion picture studio, dubbing theaters, review rooms and indoor theatres. It is intended to assist in standardization of recording monitor and reproduction characteristics of motion picture sound in rooms with volume of 150 m³ and greater. It does not apply where the recorded sound is intended for reproduction under domestic listening conditions; that is, radio and television broadcasting, tape or disc.

1.2 This standard does not cover the electro-acoustic response characteristics of motion-picture surround or effects loudspeakers, or sub-bass loudspeakers (sub-woofers).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Complete Sound Reproduction System — A system used in sound dubbing theaters, review rooms and indoor theaters; by convention consists of an A-chain (see Fig. 1).

2.2 Pre-Emphasized Sound-Track — A conventional photographic sound-track which is intended for playback over normally de-emphasized theatre playback systems. This is also known as academy sound-track.

2.3 Wide Range Sound-Track — A photographic sound-track which has been pre-emphasized and is intended for playback over a theatre playback system whose B-chain has aligned to curve X.

2.4 A-Chain (Transducer System) — The 'A' part of a motion picture sound system, as shown in Fig. 1 which extends from the transducer to the input terminals of the main fader.

2.5 B-Chain (Final Chain) — The 'B' part of a motion picture sound reproduction system as shown in Fig. 1, commencing at the input terminals of the main fader and terminating at any position in the listening area of the room or auditorium.

2.6 Electro-Acoustic Response — The electro-acoustic response of the final chain at a given position is the sound pressure level expressed in decibels with respect to an arbitrary reference pressure over a given frequency range.

2.7 Pink Noise — A continuous spectrum noise having constant energy per constant percentage bandwidth, with Gaussian probability distribution of instantaneous values.

2.8 Wide-Band Pink Noise — Pink noise having a bandwidth exceeding the frequency range of interest, typically extending from 31.5 Hz to at least 12.5 kHz.

3. CHARACTERISTICS

3.1 The electro-acoustic response of the B-chain shall be within the tolerance of Curve N given in Table 1 and Fig. 2. This response is satisfactory for record monitoring, and playback of pre-emphasized sound tracks. The Curve X and its tolerance, shown in Fig. 3 is required for recording monitoring and playback of wide-range sound tracks.

NOTE — Care should be taken that deviations from the curve though within the tolerance area, do not cause a tonal imbalance; for example, a situation where base responses were all positive and treble responses negative should be avoided.

4. METHOD OF MEASUREMENT

4.1 The electro-acoustic response shall be measured with the equipment and instruments arranged in accordance with Fig. 4.

4.2 Sound pressure level measurements shall be taken as follows:

- a) In dubbing theatres, at each of the principal listening areas;
- b) In review rooms and indoor theatres, at a sufficient number of positions to cover the listening area; and
- c) The sound level meter shall comply with IS : 3932-1966*. Both the microphone and the sound level meter shall be calibrated to provide a flat response curve and the correction factors shall be applied to allow measurements before calculating the acoustic response.

*Specification for sound level meters for general purpose use.

TABLE 1 CHARACTERISTICS OF THE B-CHAIN

(Clause 3.1)

| CENTRAL FREQUENCIES OF ONE-THIRD OCTAVE BANDS Hz | CHARACTERISTICS IN dB | | TOLERANCES IN dB | |
|---|-----------------------|---------|------------------|-----|
| | Curve N | Curve X | | |
| | | | + | - |
| (1) | (2) | (3) | (4) | (5) |
| 40 | -8 | -2 | 3 | 7 |
| 50 | -6 | -1 | 3 | 6 |
| 63 | -3 | 0 | 3 | 5 |
| 80 | -1 | 0 | 3 | 4 |
| 100 | 0 | 0 | 3 | 3 |
| 120 | 0 | 0 | 3 | 3 |
| 160 | 0 | 0 | 3 | 3 |
| 200 | 0 | 0 | 3 | 3 |
| 250 | 0 | 0 | 3 | 3 |
| 315 | 0 | 0 | 3 | 3 |
| 400 | 0 | 0 | 3 | 3 |
| 500 | 0 | 0 | 3 | 3 |
| 630 | 0 | 0 | 3 | 3 |
| 800 | 0 | 0 | 3 | 3 |
| 1 000 | 0 | 0 | 3 | 3 |
| 1 250 | 0 | 0 | 3 | 3 |
| 1 600 | 0 | 0 | 3 | 3 |
| 2 000 | 0 | 0 | 3 | 3 |
| 2 500 | -1 | -1 | 3 | 3 |
| 3 150 | -2 | -2 | 3 | 3 |
| 4 000 | -3 | -3 | 3 | 3 |
| 5 000 | -5 | -4 | 3 | 3 |
| 6 300 | -8 | -5 | 3 | 3 |
| 8 000 | -11 | -6 | 3 | 3 |
| 10 000 | -14 | -7 | 3 | 3 |
| 12 500 | -18 | -8 | 3 | 3 |

4.3 In multiple loudspeaker auditoria, the electro-acoustic response of each stage loudspeaker shall be measured individually, and each loudspeaker assembly shall be checked for consistent polarity response (see 11). With the same electrical input, normally pink noise, each loudspeaker assembly shall give the equivalent sound pressure level in the auditorium within ± 1 dB.

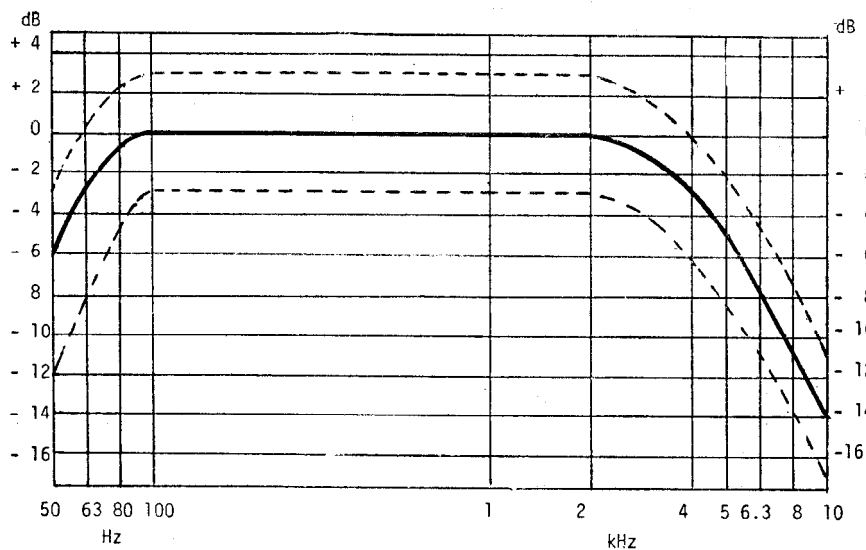
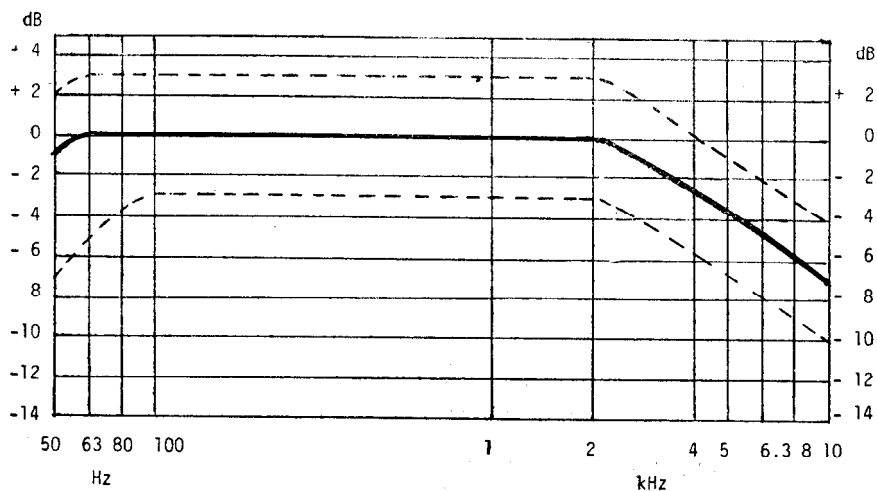


FIG. 2 CURVE N OF B-CHAIN CHARACTERISTIC



NOTE — Tolerance are based upon 1/3 octave measurement if 1/1 octave measurements are used, reduce tolerance by 1 dB.

FIG. 3 CURVE X OF B-CHAIN CHARACTERISTIC

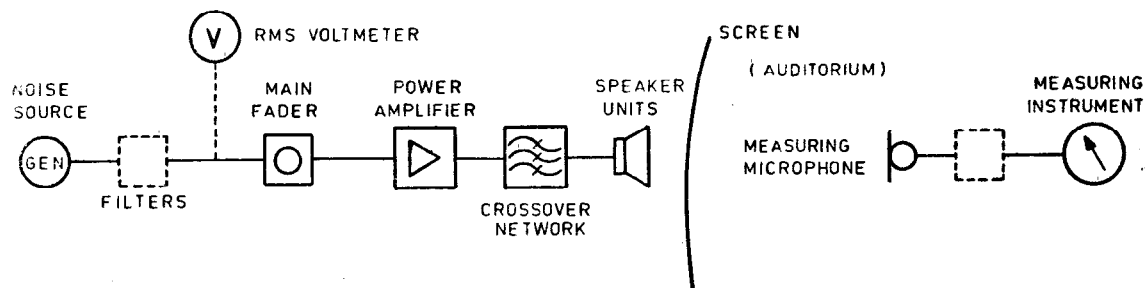


FIG. 4 METHOD OF MEASUREMENT OF B-CHAIN

4.4 At least five methods of measurement are recognized as providing appropriate data for the evaluation of the electro-acoustic responses of the B-chain. All these methods depend upon the generation of pink noise from 31.5 Hz to 10 kHz or beyond, and are as given in **4.4.1** to **4.4.3**.

4.4.1 Generate wide-band pink noise. Measure the acoustic output with a calibrated microphone intended for use in the diffuse field and an audio-frequency spectrum analyser, covering the spectrum in 1/3 octave bands.

4.4.2 Generate pink noise in 1/3 octave band with preferred central frequencies conforming to IS : 2264-1963*. Measure the signal input and the sound level meter output with an rms voltmeter and sound level meter.

4.4.3 Generate wide-band pink noise and measure the acoustic output with an rms voltmeter and sound level meter, reading acoustic output through a series of 1/3 octave bandpass filters.

4.4.4 Generate pink noise in octave bands altering the centre frequencies in either 1/1 or 1/3 octave steps. Measure the acoustic output with sound level meter as described in **4.4.2**. This procedure using full octave bands requires the tolerances on the B-chain electro-acoustic response curve be reduced as noted in Fig. 2.

4.4.5 Generate pink noise as described in **4.4.1**, **4.4.2** or **4.4.4**. With a calibrated microphone intended for use in the diffuse field, and a precision tape recorder, record the microphone output for each frequency band, where applicable, and for each measurement position. Reproduce and analyze the results by one of the methods described above at a subsequent time in an appropriate laboratory.

The pink noise test signal shall be at such a level in the auditorium to be clearly louder than any ambient noise (air-conditioning, traffic rumble, etc). The level shall not be so loud as to risk loudspeaker damage or to reach power amplifier saturation. A suitable single loudspeaker auditorium sound pressure level with wide-band pink noise is 85 dB.

5. MICROPHONE PLACEMENT

5.1 The microphone shall not be placed closer than 1.5 m from the side or near walls of the auditorium, and not closer to the screen than 25 percent of the distance to the rear wall. It shall be mounted at normal seated head height, but always at a minimum of 15 cm above the top of the back seat.

*Specification for preferred frequencies for acoustical measurements.

5.2 Care should be taken that none of the microphone placements chosen are unusual. Positions should be avoided which are exactly on lateral or transverse theatre centre lines, or are under the lip of a balcony.

5.3 To obtain a valid representation of the acoustic response throughout the listening area, it is suggested that at least three positions be averaged when employing whole octave bands, and at least five positions when employing 1/3 octave bands. In balcony houses, representative measurements should also be made in the balcony.

6. PRELIMINARY CHECKS

6.1 It is recommended that preliminary checks are made for gross acoustic errors prior to measuring the electro-acoustic response as described in this standard. Typical checks include:

- a) verification that the loudspeaker being measured is close enough to the screen to avoid any behind screen echos;
- b) there is no interference from masking or curtains; and
- c) a quick verification that the loudspeaker distribution is sufficiently smooth throughout the listening room or auditorium.

This latter test can easily be performed by ear if wide-band pink noise is available as a test signal.

7. AVERAGING

7.1 If the variations among the sound pressure levels at the different measuring positions are small, not exceeding 4 dB, the arithmetic means of these individual sound pressure levels in decibels can be made. If the variations exceed 4 dB, averaging shall be done by the sum of the squares of the sound pressure levels as follows:

$$L = 10 \log_{10} \left[\frac{1}{N} \sum_{k=1}^N \text{antilog}_{10} (L_k/10) \right]$$

where N is the number of positions and L_k is the sound pressure level at each position.

8. MINOR CORRECTIONS

8.1 The received electro-acoustic response resulting from a loudspeaker situated behind a motion-picture screen is affected by various factors before the sound is heard by a listener. These include:

- a) Attenuation of high frequencies caused by the screen. With conventional theatre loudspeakers and screens, the attenuation will be approximately 3 dB at 8 kHz. The resultant of this effect has automatically been included in the measurement technique described in 4.

- b) A room gain reverberation component added to the direct signal. This component will have a frequency response proportional to the reverberation time versus frequency characteristic. It should be noted that as the reverberation takes a finite time to build up, this component will only be measurable with quasi-steady state signals, such as pink noise, or sustained music chords. The reverberation component builds up too slowly to be added to signals of short duration, such as many speech sounds; and
- c) HF attenuation in the air, proportional to the signal path length.

8.1.1 To take account of 8.1(b) and (c), the measured characteristics to maintain a subjectively identical response will differ slightly according to auditorium size. The measured response should have a slightly attenuated high frequency characteristic in a large theatre when compared with Table 1 and Fig. 2 and 3. In the same way, there should be a slightly elevated high frequency response in a small theatre. Corrections for auditorium size are not normally required below 2 kHz, as a result of a more linear reverberation/frequency at mid-frequencies, and the ear's longer integration time at low frequencies. Determination of the above correction factors for a particular auditorium can be deduced from measurement of the reverberation/frequency characteristic (*see* Table 2).

TABLE 2 APPROXIMATE CORRECTION FACTORS FOR AUDITORIUM SIZE, IN DECIBELS

| FREQUENCY Hz | NUMBER OF SEATS | | | | | |
|-----------------|-----------------|-----|-----|-------|-------|-------|
| | 30 | 150 | 500 | 1 000 | 1 500 | 2 000 |
| 2.0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 4.0 | 1.0 | 0.5 | 0 | -0.5 | -1.0 | -1.5 |
| 8.0 | 2.0 | 1.5 | 0 | -1.0 | -2.0 | -3.0 |

NOTE — Particular care should be taken when measuring or equalizing extremely small rooms, as standing waves may make low and mid-frequency averaging techniques unreliable.

8.2 Adjustments for Humidity — Wherever possible, the electro-acoustic response should be measured with the auditorium's typical operational humidity. If abnormal humidity conditions are present, then corrections can be applied based on the following data. With respect to 1 kHz, the high frequency loss at 10 kHz per 20 m is approximately 4 dB at 20 percent humidity, 3 dB at 45 percent humidity and 2 dB at 80 percent humidity.

9. NON-CONFORMITY OF ELECTRO-ACOUSTIC RESPONSE

9.1 With an unequalized loudspeaker, the response should conform to the normal characteristics and tolerances given in Table 1 and shown in Fig. 2.

Radical deviations from the characteristics may be caused by one of the following factors:

- a) Faulty power amplifier;
- b) Incorrect or faulty loudspeaker performance;
- c) Incorrect location, orientation or directivity of the loudspeaker;
- d) Severe acoustical room defects; and
- e) Incorrect adjustment of the loudspeaker cross-over network (relative level of the bass and treble loudspeaker units), or cross-over wiring phase reversal.

Some high frequency loudspeaker units exhibit more distorting components than others; this may cause a subjective change in the high frequency response which will not be identified by the methods of test described in this standard.

10. ADOPTION OF CURVE 'X'

10.1 Adjustment of the electro-acoustic response Curve X for record monitoring and playback of wide range sound tracks will normally require some electrical equalization, typically one-third octave. The following points should be noted:

- a) The cross-over network should be adjusted to the smoothest response before equalization is attempted;
- b) Equalization above 8 kHz should not be attempted with normal theatre loudspeakers; and
- c) Equalization of room mode aberrations below approximately 100 Hz should be avoided; these specific room responses cannot be corrected with one-third octave filters without attenuation or amplification of other frequencies within the same one-third octave passband.

11. MULTIPLE LOUDSPEAKER POLARITY

11.1 In multiple loudspeaker auditoria, each stage loudspeaker should be individually checked for electro-acoustic response. After measurement and if possible, equalization, a full bandwidth pink noise test signal can be sent to combinations of loudspeakers (L and C, L and R, C and R) as a simple verification of consistent loudspeaker polarity.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

| <i>Quantity</i> | <i>Unit</i> | <i>Symbol</i> |
|---------------------------|-------------|---------------|
| Length | metre | m |
| Mass | kilogram | kg |
| Time | second | s |
| Electric current | ampere | A |
| Thermodynamic temperature | kelvin | K |
| Luminous intensity | candela | cd |
| Amount of substance | mole | mol |

Supplementary Units

| <i>Quantity</i> | <i>Unit</i> | <i>Symbol</i> |
|-----------------|-------------|---------------|
| Plane angle | radian | rad |
| Solid angle | steradian | sr |

Derived Units

| <i>Quantity</i> | <i>Unit</i> | <i>Symbol</i> | <i>Definition</i> |
|----------------------|-------------|---------------|--|
| Force | newton | N | $1 \text{ N} = 1 \text{ kg.m/s}^2$ |
| Energy | joule | J | $1 \text{ J} = 1 \text{ N.m}$ |
| Power | watt | W | $1 \text{ W} = 1 \text{ J/s}$ |
| Flux | weber | Wb | $1 \text{ Wb} = 1 \text{ V.s}$ |
| Flux density | tesla | T | $1 \text{ T} = 1 \text{ Wb/m}^2$ |
| Frequency | hertz | Hz | $1 \text{ Hz} = 1 \text{ c/s (s}^{-1}\text{)}$ |
| Electric conductance | siemens | S | $1 \text{ S} = 1 \text{ A/V}$ |
| Electromotive force | volts | V | $1 \text{ V} = 1 \text{ W/A}$ |
| Pressure, stress | pascal | Pa | $1 \text{ Pa} = 1 \text{ N/m}^2$ |

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